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PACALL: Passive Capture for Ubiquitous Learning Log Using SenseCam

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Abstract: In our previous works, we developed a system named SCROLL in order to log, organize, recall and evaluate the learning log. However up to now, we just use an active mode to record logs. This means that a learner must take a capture of learned contents consciously and most of learning chances be lost unconsciously. In order to solve this problem, we started a project named PACALL (Passive Capture for Learning Log) in order to have a passive capture using SenseCam. With the help of SenseCam, learner's activity can be captured as a series of images. We also developed a system to help a learner find the important images by analyzing sensor data and images processing technology. Finally, the selected images will be uploaded to the current SCROLL system as ubiquitous learning logs. This research suggests that SenseCam can be used to do passive capture of learning experiences and workload of reflection can be reduced by analyzing sensor data of SenseCam.

Keywords: passive capture, learning log, life log, sensor data, SenseCam, ubiquitous learning

Introduction

Learning Log was originally designed for children as a personalized learning resource [6]. It was set by teachers to help their students record their thinking and learning. In this learning log, the logs were usually visually written notes of learning journals. We defined a ubiquitous learning log as a digital record of what a learner has learned in the daily life using ubiquitous technologies. We developed a system SCROLL (System for Capturing and Reminding Of Learning Log) [10] that helps learners collect their learning experiences as ubiquitous learning objects (ULLOs). Also, all of the collected ULLOs are organized, shared in this system, and the learning effect can be enhanced. The model of a learning process is shown in Figure 1 and we call it LORE [10].

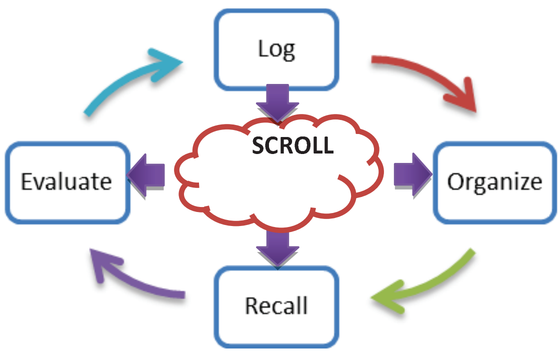

Figure 1. LORE Model in SCROLL

However, in the current SCROLL ULLOs are created by learners manually. It means that learners must record their learning experiences in the form of photo, video or other formats consciously. It is evident that learners cannot record all of the learning experiences in the system and most of them will be lost and forgotten.
In order to solve this problem, we attempt to introduce the concept of life log into this system. The notion of life log can be tracked back at least 60 years [1]. It means to capture a person's entire life or large portions of life. It usually uses digital devices to record life log such as wearable cameras or video recorders. For example, in the early 1980s Steve Mann captured his life using wearable computer and streaming video and even his everyday life 24 hours a day in order to see what he was looking at [7]. The life log brings us the data of whole life of not only learning but also other activities. However, if there is any way that we can extract the learning part from it, the learning log will be more significant and more sufficient. Besides, our system captures the learning log beyond their consciousness and learners' burden will also be reduced.
Microsoft's SenseCam [4] is an effective way to capture the life log. It is a wearable camera equipped with a number of sensors. The SenseCam is proposed to record a series of images and capturing a log of sensor data.
In this paper, we propose a system named PACALL (PAssive CApture for Learning Log) to capture the learning log passively using Microsoft's SenseCam. With the help of analyzing sensor data and image processing technology, it extracts the meaningful images for learning from life log and helps learners upload the learning content easily. In addition, we also conducted an initial experiment and analyzed the result.

1. Related Works

1.1 MyLifeBits

MyLifeBits [9] is a Microsoft's project. The aim of this project is to implement Bush's Memex model [1] that proposed to store everything that you saw and you heard.
MyLifeBits has a large amount of storage that can store email messages, web pages, books, photos, sounds, videos, etc. It also has a full-text search function to supply users with searching text, audio annotations and hyperlinks.
In addition, the MyLifeBits project team is also using SenseCam to have the passive capture of life log and upload the sensor information along with the photos to the MyLifeBits repository [3].
We have learned a lot from this system. In our previous works, we had made it possible to store the learned material such as photos, sounds, videos and pdf files into the system repository. Besides, we have also implemented recall functions that use quizzes and contextual information to help learners to remember what they have learned. However, all works that we have done are using active logging mode, not passive logging mode. It means that learners must record their learning experiences as learning material by themselves. Comparing to the passive mode, in the active mode we are more likely to lose learning experiences since we are not necessarily able to record what we have learned or sometimes we just forget to record it. Therefore, we planned to introduce passive capture in our project with SenseCam.

1.2 JAMIOLAS

JAMIOLAS [11] is Japanese mimicry and onomatopoeia learning assistant system. This system uses sensor to get the context information from real world such as temperature, light and sound level and use these data to support learning Japanese mimicry and onomatopoeia words. Because most of these words are just Japanese feelings, this system simulates the feeling of human beings with sensors, and generates proper word to help non-Japanese learners learning mimicry and onomatopoeia words. Each word has relationships with a number of sensors. Sensor data types are attributes of the word. For example, "hiyahiya" means cold in Japanese, so this word has a relationship with temperature sensor, and the temperature data is an attribute of "hiyahiya". The threshold is set by native Japanese speakers. In the second generation of JAMIOLAS [8], sensor network was introduced into this system, and in the third generation [5] this system also used online sensor data and supported learning mimicry and onomatopoeia with multimedia materials.
In the PACALL, we also use the sensor data to analyze the situation of an image file. When sensor data is collected by combined sensors, we need to analyze the sensor data, evaluate it as a situation and all the information will be added to each photo as properties.

1.3 Collaborative Reflection with SensorCam

Fleck and Fitzpatrick [2] used SensorCam to support collaborative reflection. In their research, the students were asked to wear SenseCam when they played arcade games. After that, they did a reflection on their learning experiences. They found that SenseCam images were not only used to support memory aids but also can be used as resources for supporting the collaborative reflective discussion. The research also suggests SenseCam has potential to support reflection and that it is more appropriate in learning situation than videos.

2. SenseCam

SenseCam is a prototype device under the development of Microsoft Research [4]. It is a small digital camera that is combined with a number of sensors to help to capture a series of images of the wearer's whole daily life at the proper time and it can be worn around the neck (Figure 2). Actually this device is designed for memory aid.

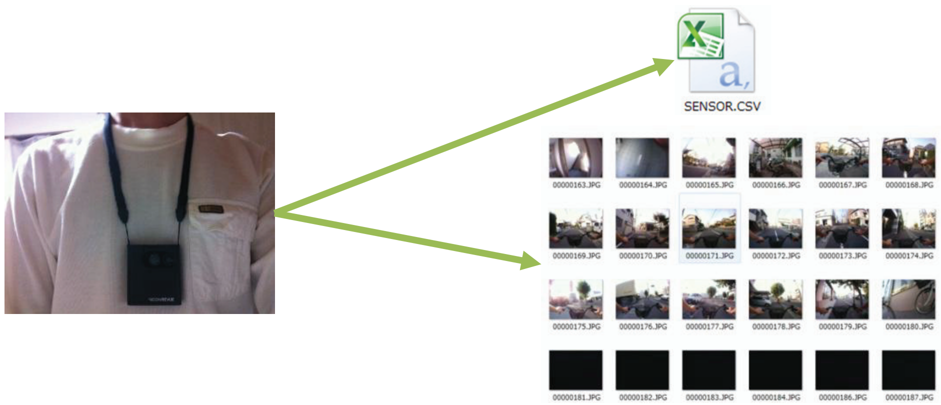

Figure 2. SenseCam and the record data

The SenseCam uses sensors as triggers to capture images along with a time trigger. As it is shown in Figure 2, when using the SenseCam all actions are saved into a single file named SENSOR.CSV including sensor data and the names of photos. Once the SenseCam is connected to computer, all the photos and the SENSOR.CSV file will be imported automatically.

```
CAM,2010/09/16 11:43:57,00000115.JPG,P
ACC,2010/09/16 11:44:20,00.037,00.940,-0.231
TMP,2010/09/16 11:44:20,0032.0
CLR,2010/09/16 11:44:20,00132
PIR,2010/09/16 11:44:20,1
BAT,2010/09/16 11:44:20,40992
MAG,2010/09/16 11:44:20,-374,892,-1924
```

Figure 3. Example of SENSOR.CSV

Figure 3 is an example of SENSOR.CSV. Each line starts with a flag (e.g. CAM, ACC) and a timestamp. Meanings of some flags that we are using in this research are shown in Table 1.

Table 1. Flags in SENSOR.CSV

Flag	Sensor/Meaning	Data Interpretation
CAM	Image capture	Image filename, capture reason (P: PIR, T: Timer, M: Manual, L: Light level change)
PIR	Passive infrared detector	1: the PIR is triggered, 0: not triggered
CLR	Color light sensor	Value for ‘white’ light
TMP	Temperature sensor	Temperature
ACC	Accelerometer	Acceleration values in x, y and z axis
MAG	Magnetic sensor	Magnetic values in x, y and z axis

The SenseCam itself has an algorithm for capturing images by a time trigger and other triggers that use sensor data. However, because SenseCam is designed for memory aid, it takes photos continuously even if it is dark or the situation is not been changed. The result is that there are so many photos that are duplicated or blurred or dark.
In this research, we focus on filtering the images with sensor data in order to help learners to select proper photos in a short time.

3. Research Design

3.1 Learning Process

This research is a sub-item of Ubiquitous Learning Log, and we named it as PACALL. It means a passive capture for learning log. The whole process of passive capture happens unconsciously. However it is no doubt that the simple photo capture is not the whole process of learning. It is necessary for learners to look through the captured photos and find the learning contents with the help of system. After entering the information of the image such as title and description, this learning content will be saved into SCROLL system as a ULLO. Of course, the saved ULLOs need to be recalled to help learners to remember, but this is the feature of SCROLL. That is to say, a process of passive capture includes capture, reflect and store. Such process is called a PACALL frame.

- Capture: Capture a series of photos for life log in daily life. This log is assumed that it includes all what learner has seen. Besides, massive redundant contents are also included in this log. We use SenseCam in the process of capture. SenseCam is already introduced in section 2.

- Reflect: After capturing life log, a learner needs to have a reflection of what he has learned. In this process, since there are so many photos, we provide a system to filter the redundant photos by analyzing sensor data or image processing technology. The analysis of sensor data is described in section 3.2.
- Store: When a learner finds an important learned content, the content must be stored into SCROLL. During this process, he also needs to enter the information of learned content such as title, description or tags.

3.2 Photo Classification and Sensor Data

In PACALL, we use SenseCam to have a passive capture of learner's daily life. However, since this device takes photos continuously, more than 200 photos will be taken in one hour, and more than 1500 photos in one day. Therefore, we propose a method to classify these photos by sensor data.
All photos are divided into 5 levels based on importance – manual, normal, duplicate, shake and dark.

- Manual: Manual means the photo is taken by pressing manual button consciously. When a learner takes a photo manually, it means that this photo must be important from his point of view. Manual photos are selected by the sensor data with flag CAM and the capture reason "M" (manual capture).
- Normal: Normal means the photo is clear and can be used as learning log object. After excluding the duplicates, shake and dark, left photos are judged as normal.
- Duplicate: Duplicate means the photos are duplicated. Duplicated photos usually have same conditions. We use CLR, TMP, ACC, MAG and timestamp of photo to detect photos that are taken under the same conditions and pick out them as duplicated photos.
- Shake: Shake means the photo is blurred. It usually happens when the light level is low and the camera shakes. The sensor data CLR help us detect light level and ACC help us detect camera shake.
- Dark: Dark means the photo is taken with insufficient light and the photo is dark. It can be detected by CLR data.

Figure 4 shows the process of photo classification.

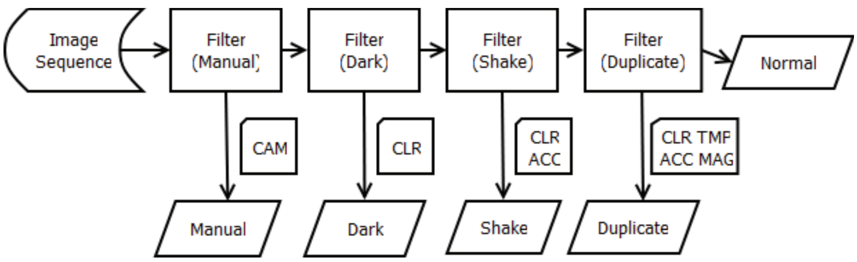

Figure 4. Process of Photo Classification

4. Implementation and Initial Evaluation

4.1 System Architecture

In this research, the SenseCam that we are using is produced by Vicon Revue [12]. When the SenseCam is connected to the computer, if the software Vicon Revue Desktop is already installed, all photos will be imported into computer. The location of SenseCam repository is in the user's document folder and the name is Vicon Revue Data.
This system is programmed using Java and runs in Tomcat as a B/S system. When using this system, Tomcat accesses the repository of SensorCam photos directly and shows them in web browser.

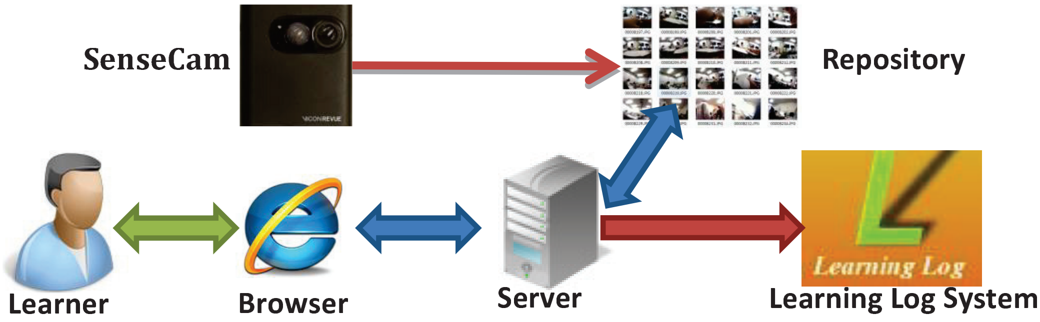

Figure 5. System Architecture

Figure 5 shows the system architecture. All the photos captured by SenseCam and sensor data are imported into repository. When a learner uses this system through browser, server accesses repository and analyzes the photos by sensor data, then returns the classified photos to learner. Then he selects proper photos and uploads them to learning log system through the server. We have a plan to use image processing technology to detect the photos which contains faces or texts.

4.2 User Interface

When the learner starts this system, s/he is required to enter the username and password as the same as SCROLL system. If this is the first time that learner logs in, system will ask learner input the location of sensor data path. This setting can be changed at any time by the setting page. The sensor data path must contain the sensor data file (data_v3.sql), and since the security issues, learner cannot choose the folder directly by file select dialog. For the Vicon Revue SenseCam, this folder is usually named "Vicon Revue Data" and located at user's documents folder. When the SenseCam connects to the computer, all the data will be import into this folder automatically.
After that, life-log picture folders will be shown to them including the name of the folder, picture number and last updated time. Each folder contains photos for a PACALL frame. Here, the name will be used to locate the folder directly in file explorer. Sometimes, if a SenseCam has no picture and is connected to a computer, a life-log picture folder will be also created with no data. Picture number makes it clear, and save the time when the learner selects life-log picture folder.
When the learner selects a new folder, the system will analyze the file SENSOR.CSV in this folder. Because in this file, the sensor data is record as event flow, we need to analyze it and get the sensor information of each picture. At the end of this process, the information of each picture will be saved into database and the life-log picture browser page will be shown (Figure 6 left). On the top of this page, classifications are shown like menus including ALL, MANUAL, NORMAL, DUPLICATE, SHAKE and DARK. The numbers of pictures in each classification are shown on the side of classification. There is also a function that let users change the lines of pictures per page. It is very useful when user wants to view all of the pictures or do not want to drag the scroll bar.

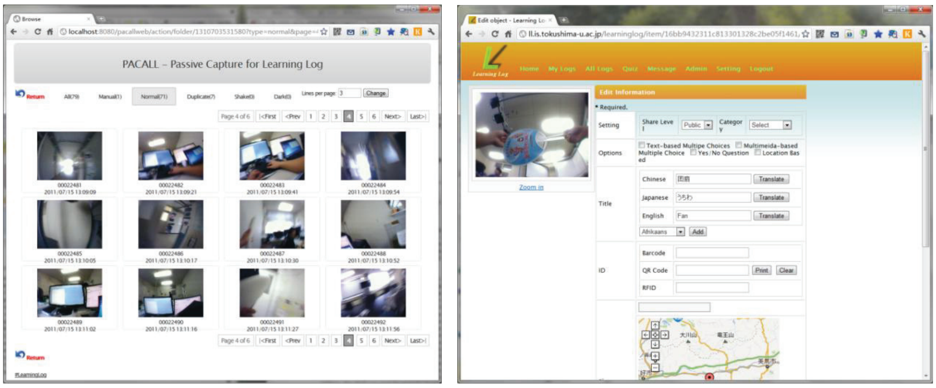

Figure 6. Interface

Once the learner clicks a picture, the system will show a page to view the large picture and help learner upload the picture to SCROLL. Currently, this page is very simple, and there are two buttons – "Upload it" and "Close" and one picture on it. However, in the future, we plan to expand this page and show the similar pictures from remote server on it.
If leaner decides to upload this picture to the server, s/he can click the "Upload it" button. Then the picture will be uploaded to the SCROLL system directly and the page will jump to the learning log registration page (Figure 6 right). On the learning log registration page, learner is required to input the title of the picture. The title is usually the name of the object in this picture. Location and other options are also supported on this page. When an object is registered to the system, SCROLL system will use "organize", "recall" and "evaluate" model to help learner remember uploaded objects and vocabularies. For example, system will remind learner this vocabulary by quizzes.

4.3 Initial Evaluation

This is an initial evaluation experiment. We have conducted this experiment on computer and the target is to see the effect of analyzing sensor data.
Firstly, we use SenseCam to capture daily life. Then using PACALL to classify the photos and review the accuracy rate. This process has been conducted for three times. Table 2 shows the result of this experiment.

Table 2. Result of Evaluation Experiment

No.	Capture time	Total number	Normal (correct/total)	Duplicate (correct/total)	Shake (correct/total)	Dark (correct/total)
1	2.5h	683	544/579	1/1	26/28	41/73
2	4.8h	1089	377/434	383/383	8/16	166/253
3	24h	2467	46/86	1800/1800	0/5	568/568

No.1 was captured in a common daily life, and no.2 was captured in a conference, and the no.3 was captured when we left SenseCam on the table during 24hrs. From this table, we learned that duplicate has the highest accuracy rate. It means in duplicate tab, all of photos are duplicated. But the results of shake and dark were not sufficient enough. After analyzing data manually, we have noticed that value from color light sensor is not changed immediately upon the light change but photo is usually taken at that time.
On the whole, this system is helpful for reducing the workload enough and usable for reflection. In the future, we will also use image processing technology to improve this system.

5. Conclusion and Future Work

In this paper, we introduced a project named PACALL that supports passive capture for learning log using SenseCam. We have designed a model of learning process in passive capture mode including capture, reflect, store. The PACALL system has been also developed in order to support reflection and reduce the workload of reviewing photos. During this research, we found that the SenseCam that originally designed for memory aid can be also used to capture learning log for passive mode. However, it usually takes too many photos, and many of them are duplicated or dark. Therefore, we must introduce other technology to help learners find out important photos. Currently, we are using sensor data to help us do it. In the future, we also use images processing technology to detect the contents of photos. Besides, current algorithm and user interface also need improvement. In addition, we plan to conduct a full evaluation experiment and invite students to use this system in the near future.

Acknowledge

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References

[1] Bush, V. (1945). As we may think. *the atlantic monthly*, *176*(1), 101–108.
[2] Fleck, R., & Fitzpatrick, G. (2006). Supporting collaborative reflection with passive image capture. *Supplementary Proceedings of COOP'06* (pp 41-48).
[3] Gemmell, J., Williams, L., Wood, K., Lueder, R., & Bell, G. (2004). Passive capture and ensuing issues for a personal lifetime store. *Proceedings of the the 1st ACM workshop on Continuous archival and retrieval of personal experiences* (pp 48-55).
[4] Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth, G., et al. (2006). SenseCam: A retrospective memory aid. *UbiComp 2006: Proceedings* (pp 177-193). Presented at the UbiComp 2006, Orange County, CA, USA.
[5] Hou, B., Ogata, H., Miyata, M., Li, M., Liu, Y., & Yano, Y. (2010). JAMIOLAS 3.0: Supporting Japanese Mimicry and Onomatopoeia Learning Using Sensor Data. *International Journal of Mobile and Blended Learning (IJMBL)*, *2*(1), 40–54.
[6] Learning log - Wikipedia, the free encyclopedia. (nd). Retrieved January 3, 2011, from http://en.wikipedia.org/wiki/Learning_log
[7] Mann, S., Picard, R. W., & Section, M. I. of T. P. C. (1995). *On being'undigital'with digital cameras: Extending dynamic range by combining differently exposed pictures*. Citeseer.
[8] Miyata, M., Ogata, H., Kondo, T., & Yano, Y. (2008). JAMIOLAS 2.0: Supporting to Learn Japanese Mimetic Words and Onomatopoeia with Wireless Sensor Networks (pp 643-650). Presented at the International Conference on Computer in Education, Taipei.
[9] MyLifeBits - Microsoft Research. (nd). Retrieved May 19, 2011, from http://research.microsoft.com/en-us/projects/mylifebits/
[10] Ogata, H., Li, M., Hou, B., Uosaki, N., Moushir, M. E.-B., & Yano, Y. (2010). SCROLL: Supporting to Share and Reuse Ubiquitous Learning Log in the Context of Language Learning. *Proc. of mLearn 2010* (pp 40-47). Presented at the mLearn 2010, Malta.
[11] Ogata, H., Yin, C., & Yano, Y. (2006). JAMIOLAS: Supporting Japanese Mimicry and Onomatopoeia Learning with Sensors (pp 111-115). Presented at the Wireless, Mobile and Ubiquitous Technology in Education, 2006. WMUTE '06.
[12] Vicon Revue | Memories for life. (nd). Retrieved May 26, 2011, from http://www.viconrevue.com/